Status from the LDT simulation

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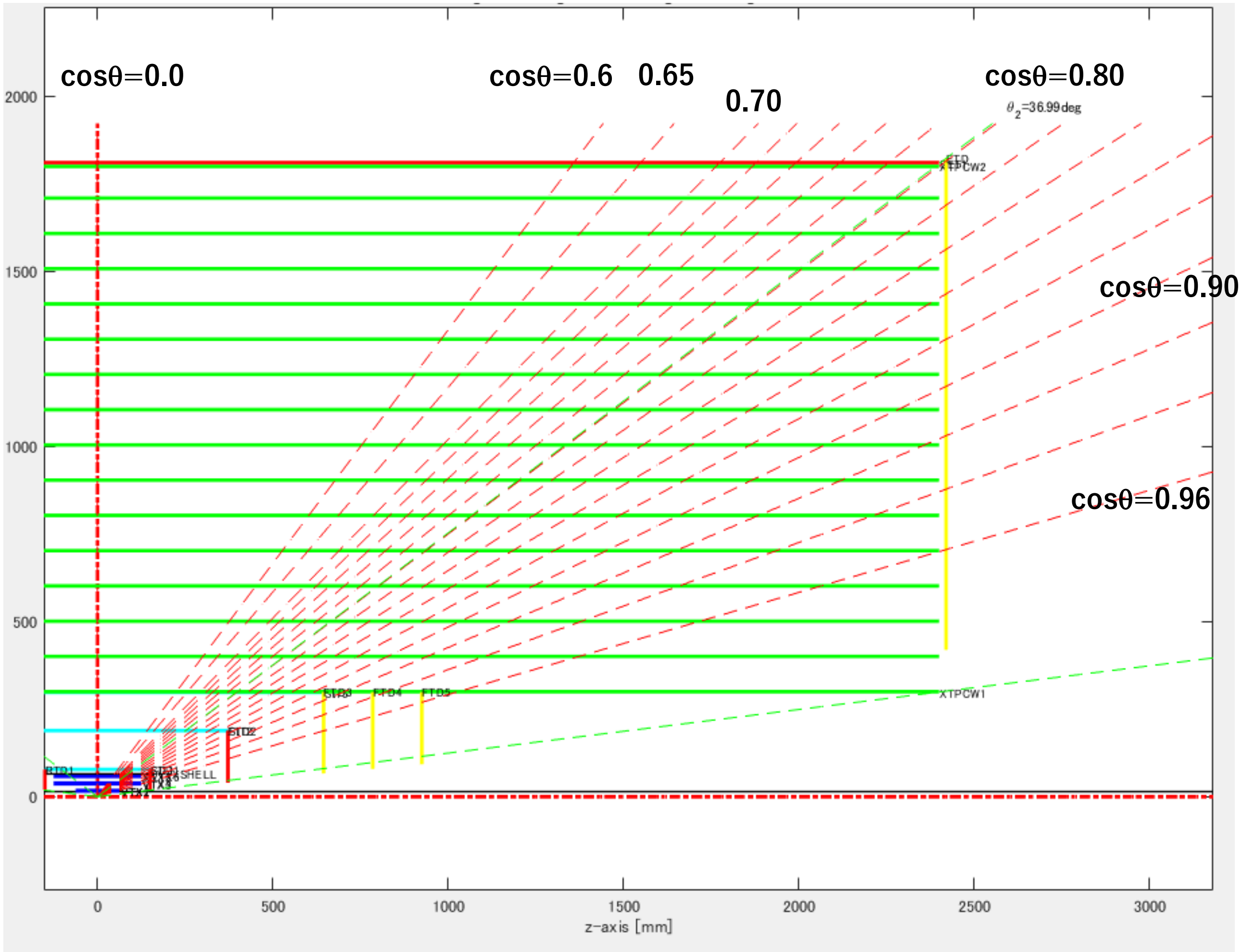
03/29/2021

Updates

- Number of hit layers
- Fitting function

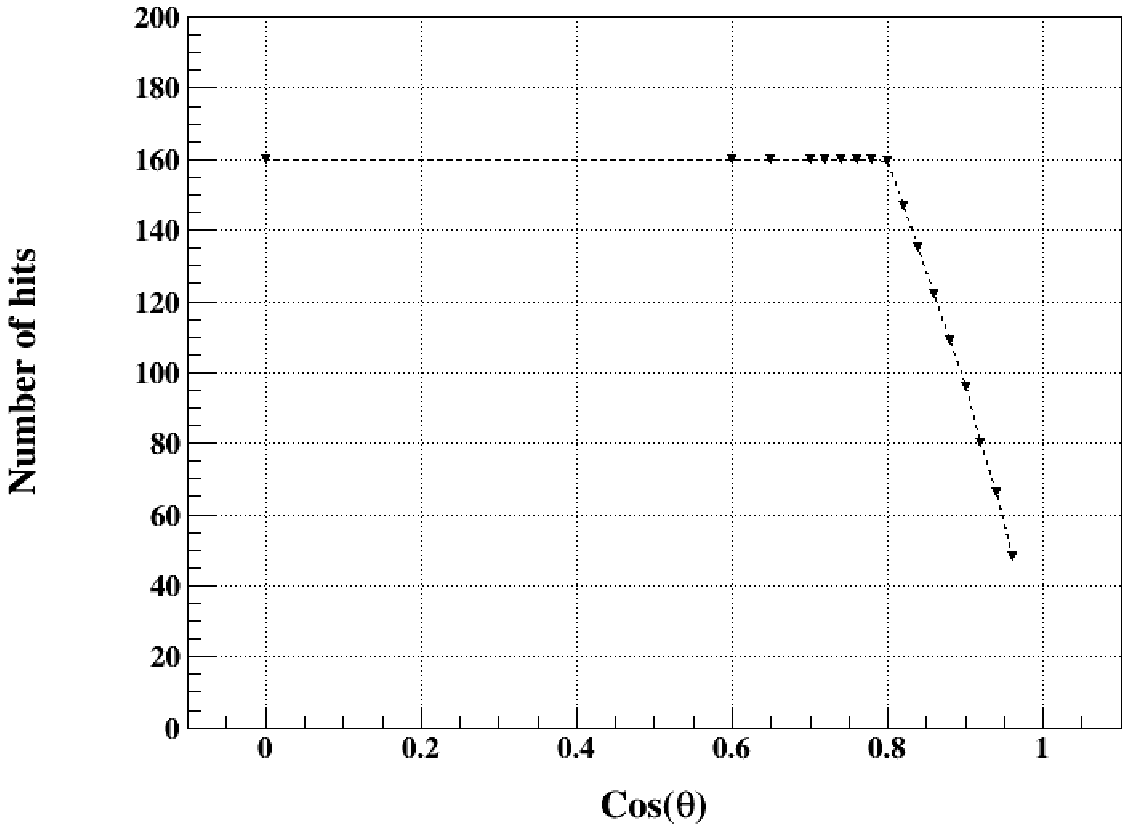
Number of hit layers and injection angle

- R=1.8m
- cos(θ)=0.0, 0.6, 0.65, 0.70, 0.72, 0.74, … 0.96
- Forward detector configuration is that of Feb. version.

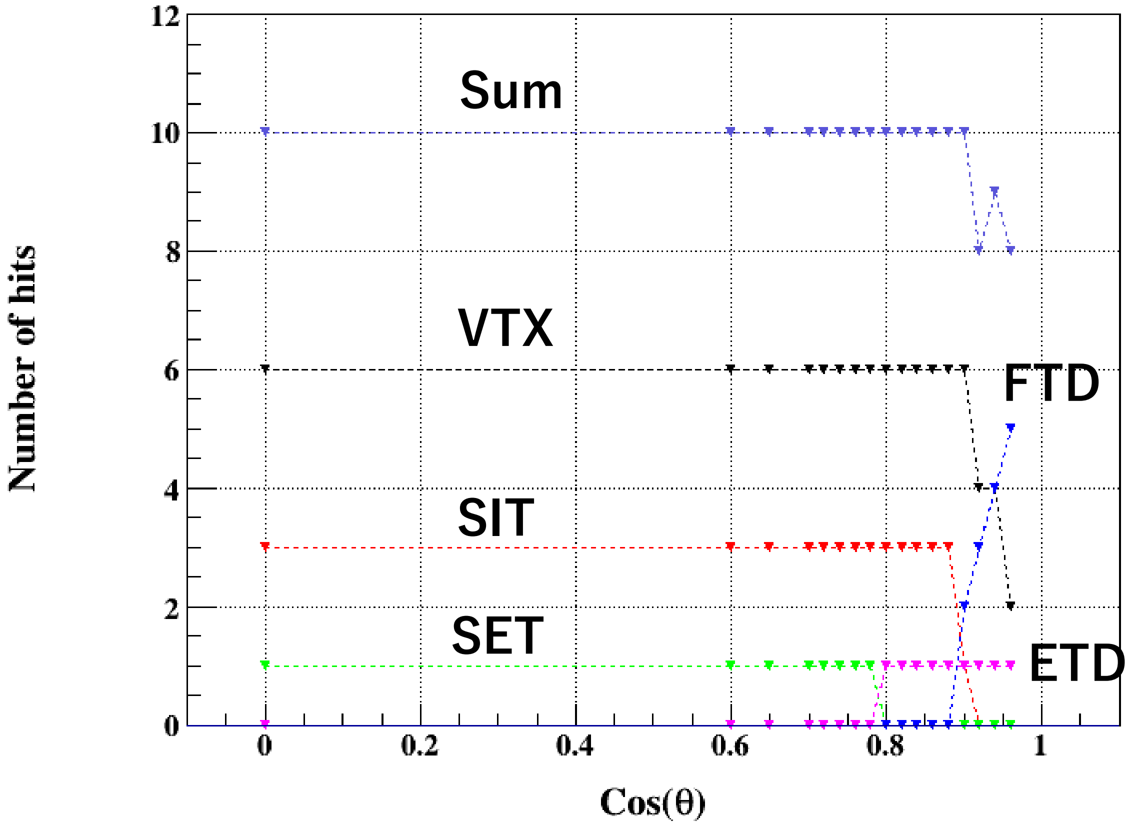


Number of hit layers and injection angle

Total number of hits



Number of hits except DCH

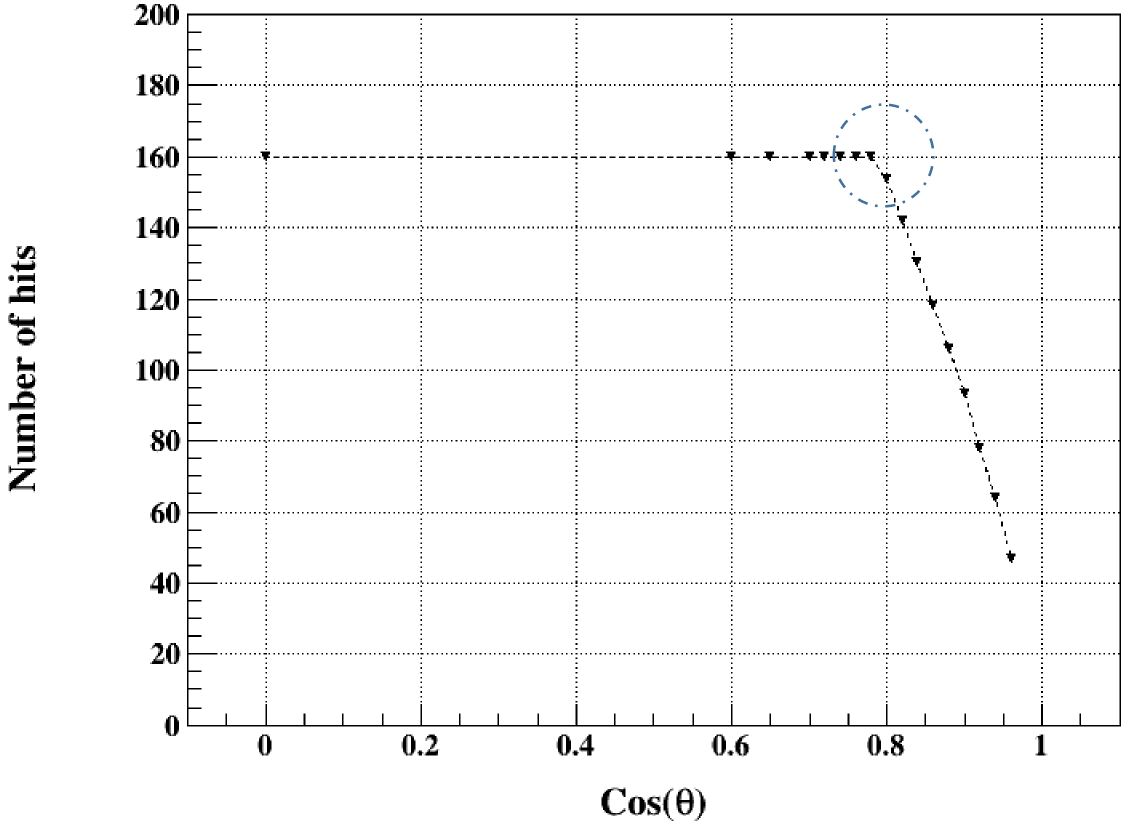


P=100GeV

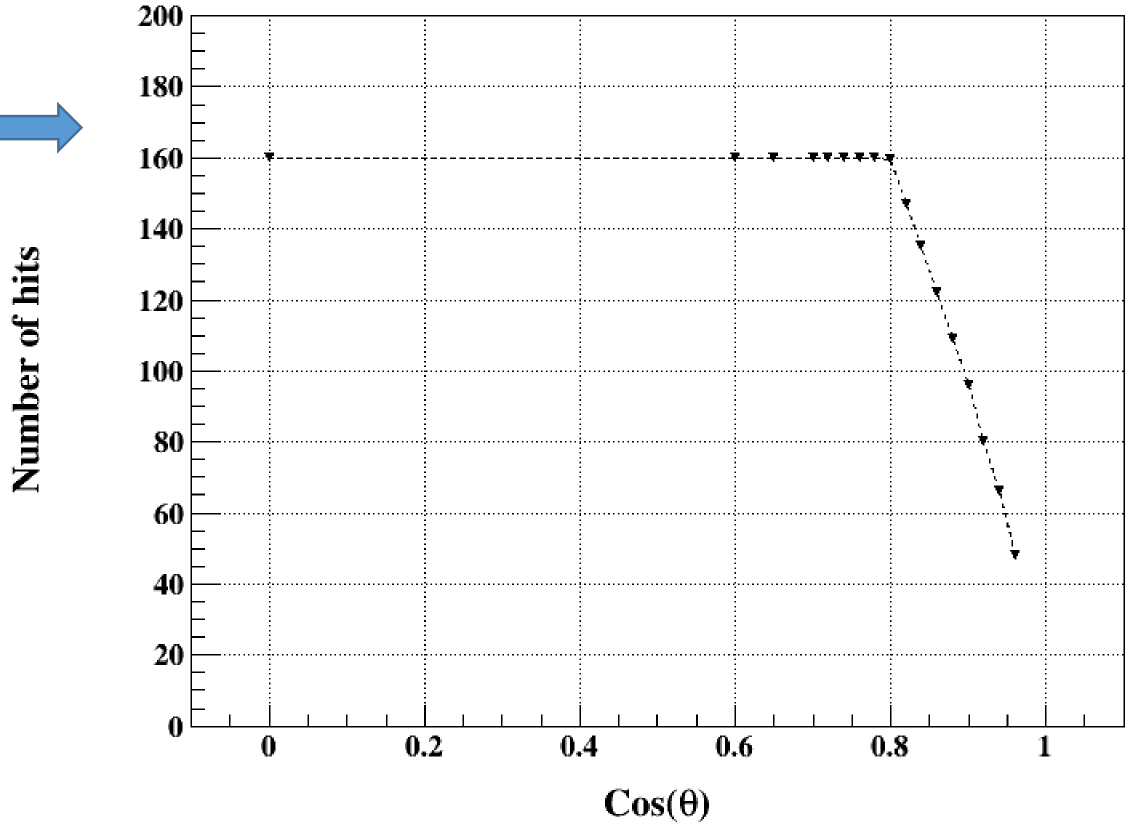
looks that Nhit>100 is achieved till cos(θ)~0.85

Number of hits and injection momentum

not so much difference . . .



P=3GeV



P=100GeV

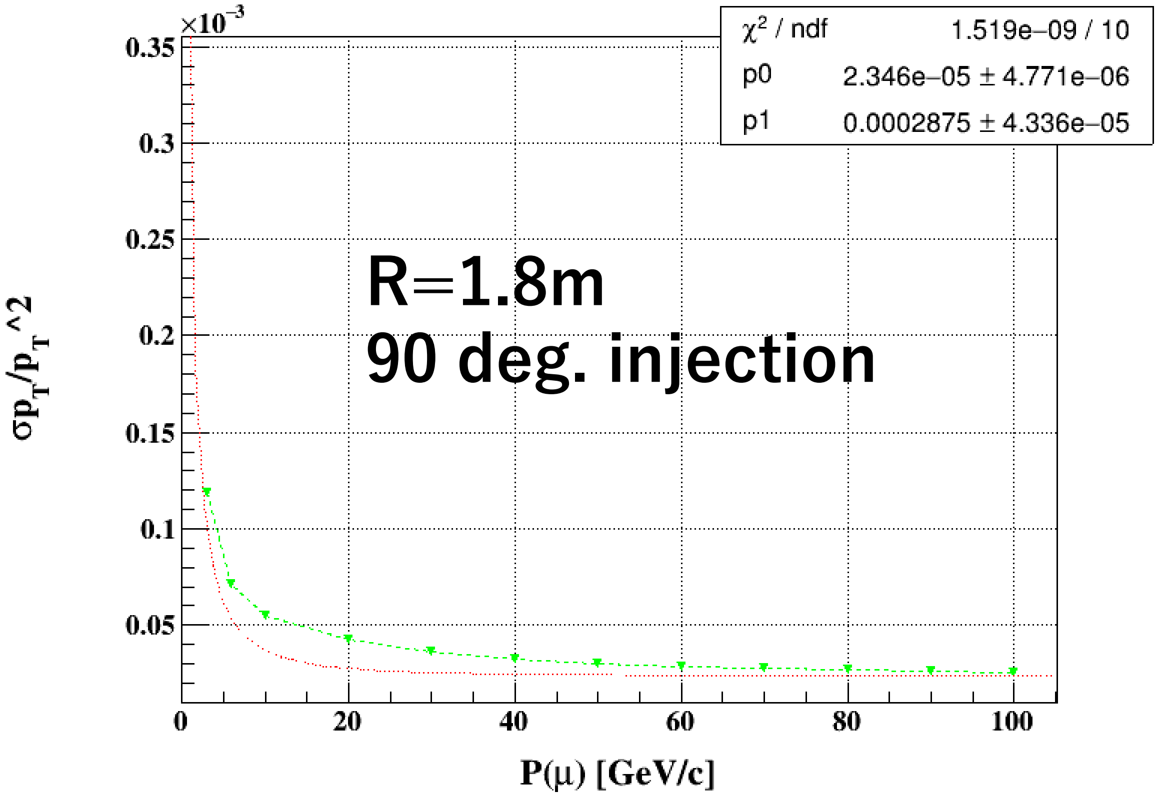
σ(1/pt) with fitting

formula :

$$\sigma_{1/P_T} = a \oplus \frac{b}{P_T \sin^{1/2}\theta} = a \oplus \frac{b}{P \sin^{3/2}\theta}$$

A fitting function $\rightarrow \sqrt{a^2 + \frac{1}{P^2} \cdot \frac{b^2}{\sin^3\theta}}$

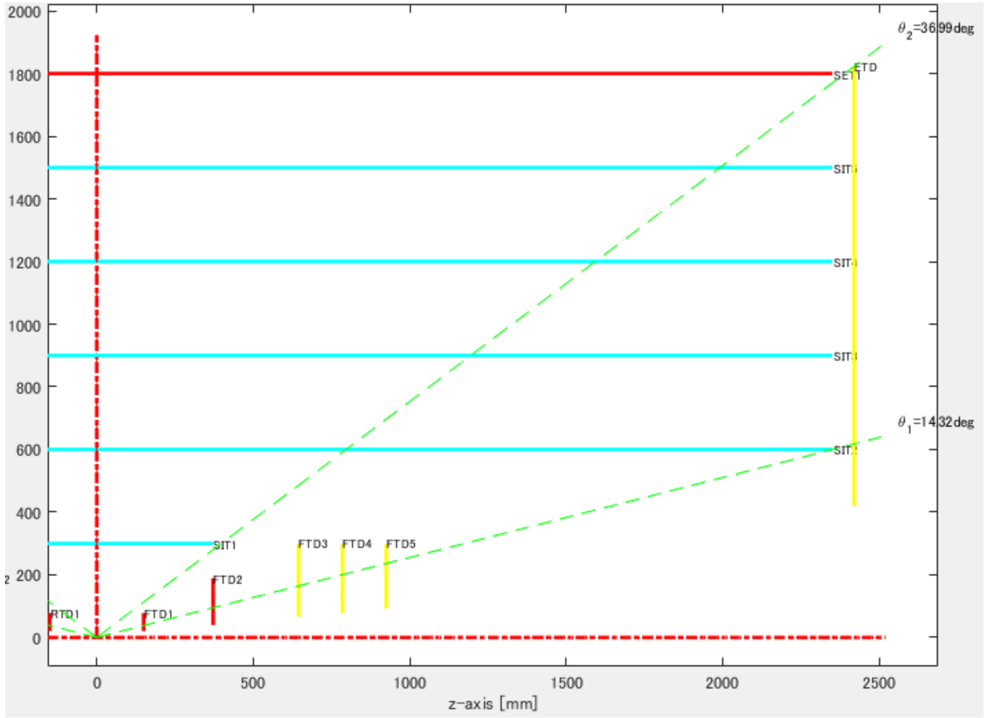
(θ = 90 degree, therefore, sin=1)

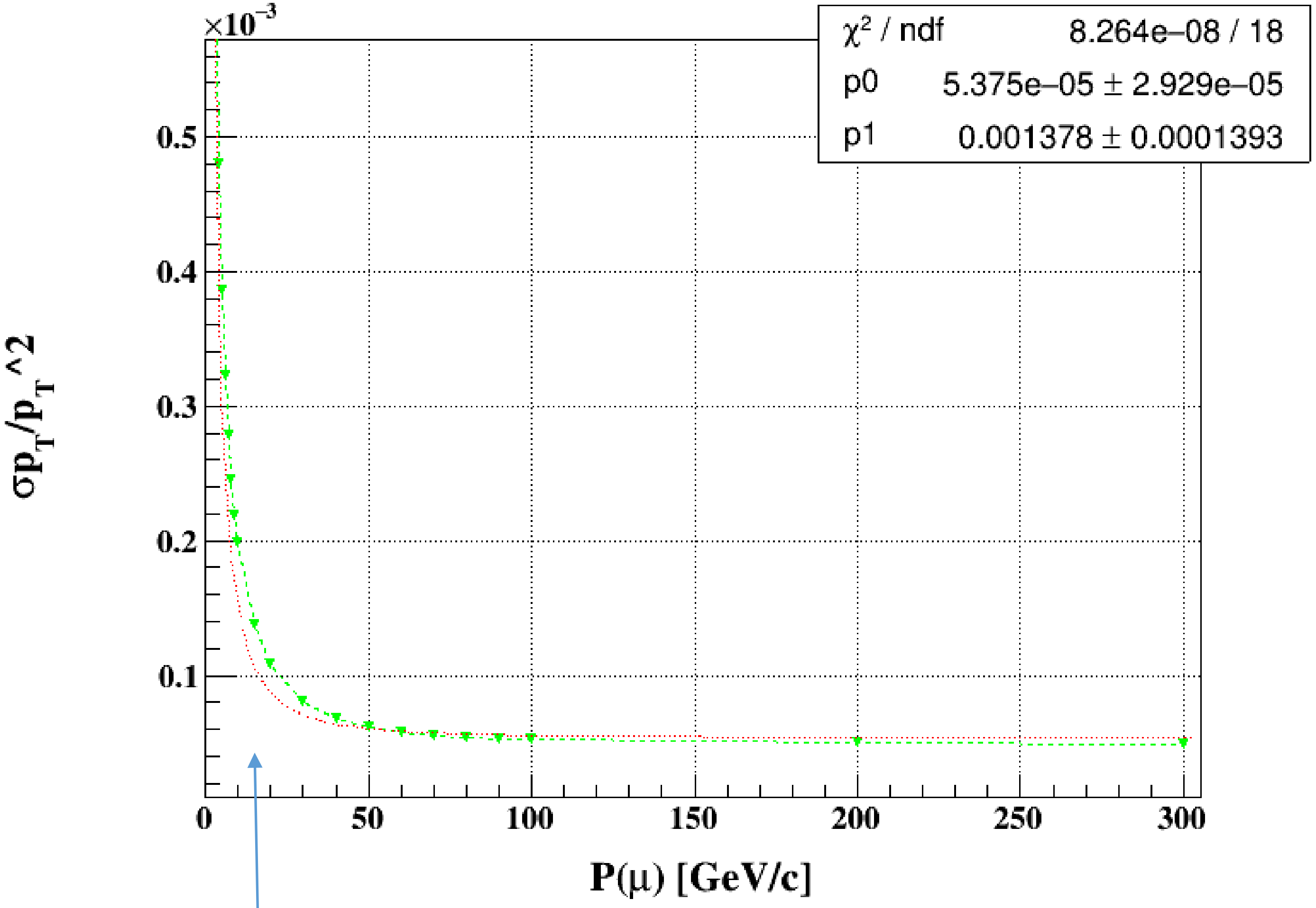


-- “a” ~ 2× 10^{-5} is what we expect from R=1.8m

-- Discrepancy between data points & fitting line. Partially, the configuration is not the one assumed in the formula. Is that also related to reconstruction ?

Ref: Fit to data points with equal spacing SITs





a bit discrepancy . . .

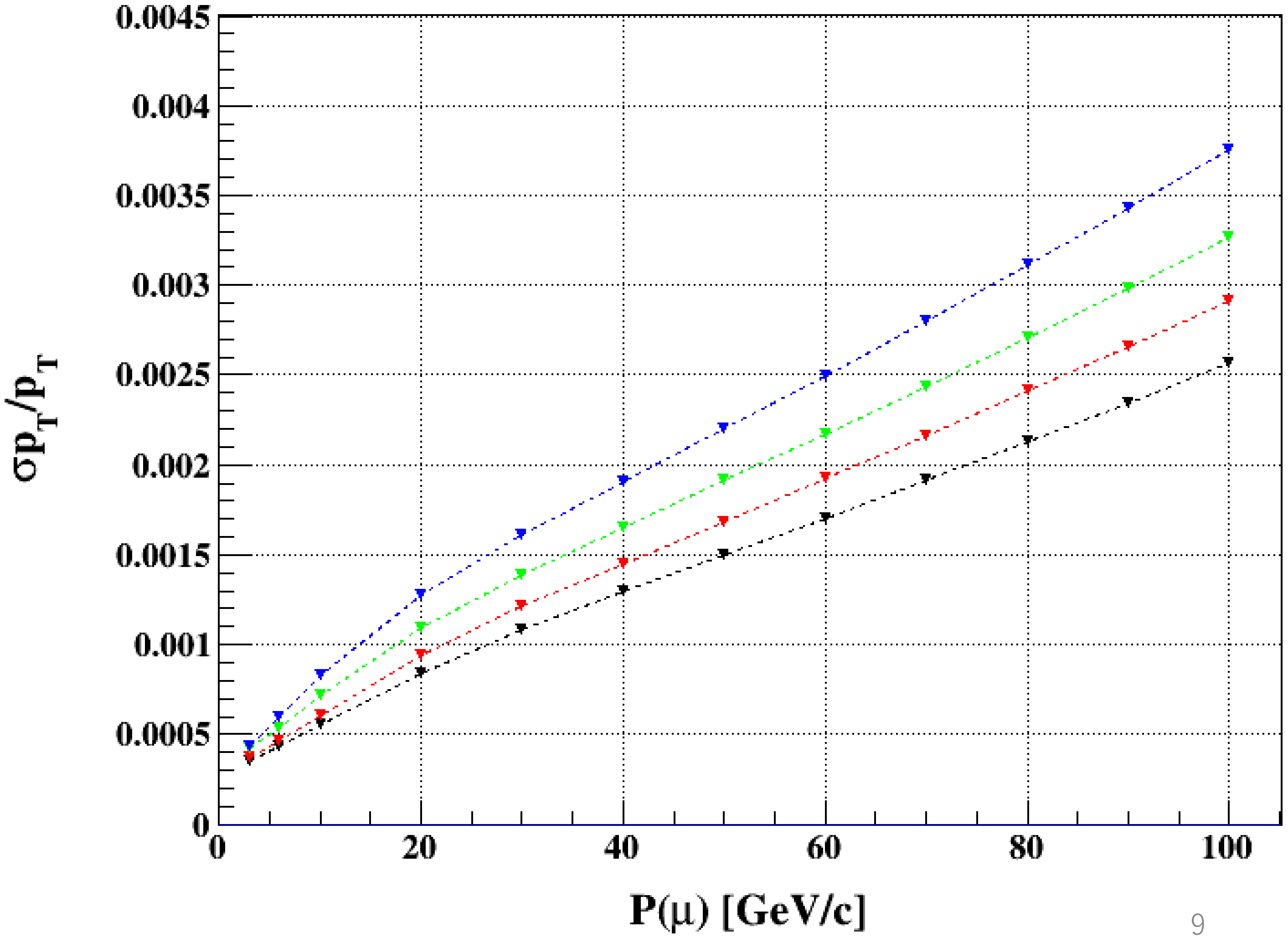
Next

- Confirmation of the reconstruction routine in the LDT
- Necessary updates, confirmation for workshop if needed.

Momentum resolution with different tracker radius

Continue from last Monday.
Change the radius of tracker

	Tracker R_{max}	DCH
Black	1800 mm	300-1800mm
Red	1700	300-1700
Breen	1600	300-1600
Blue	1500	300-1500



$$\sigma_\alpha^0 = \frac{1}{\beta p_T[GeV/c]} f\left(\frac{d}{X_0}\right) , \quad f(y) = 0.0136\sqrt{y}(1+0.038\ln y) , \quad \sigma_\alpha \approx \frac{\sigma_\alpha^0}{\sqrt{\sin\theta}}$$

$$\frac{\Delta p_T}{p_T}|_{res.} \approx \frac{12\sigma_{r\phi}\, p_T}{0.3\, BL^2}\sqrt{\frac{5}{N+5}}$$

$$\frac{\Delta p_T}{p_T}|_{m.s.} \approx \frac{\sigma_\alpha^0 p_T \sqrt{N+1}}{0.3BL\sqrt{\sin\theta}}$$

$$\Delta d_0|_{res.} \approx \frac{3\sigma_{r\phi}}{\sqrt{N+5}}$$

$$\Delta d_0|_{m.s.} \approx \frac{\sigma_\alpha^0 r_0}{\sqrt{\sin\theta}}$$

$$\Delta z_0|_{res.} \approx \frac{2\sigma_z}{\sqrt{(N+3)}}$$

$$\Delta z_0|_{m.s.} \approx \frac{r_0\sigma_\alpha^0}{\sin^{\frac{3}{2}}\theta}$$

$$\Delta\phi|_{res.} \approx \frac{\sigma_{r\phi}}{L}\frac{8\sqrt{3}}{\sqrt{N+5}}$$

$$\Delta\phi|_{m.s.} \approx \frac{\sigma_\alpha^0}{\sqrt{\sin\theta}}$$

$$\Delta\theta|_{res.} \approx \frac{2\sigma_z \sin^2\theta}{L}\sqrt{\frac{3}{(N+3))}}$$

$$\Delta\theta|_{m.s.} = \sigma_\alpha^0 \sin^{\frac{1}{2}}\theta$$

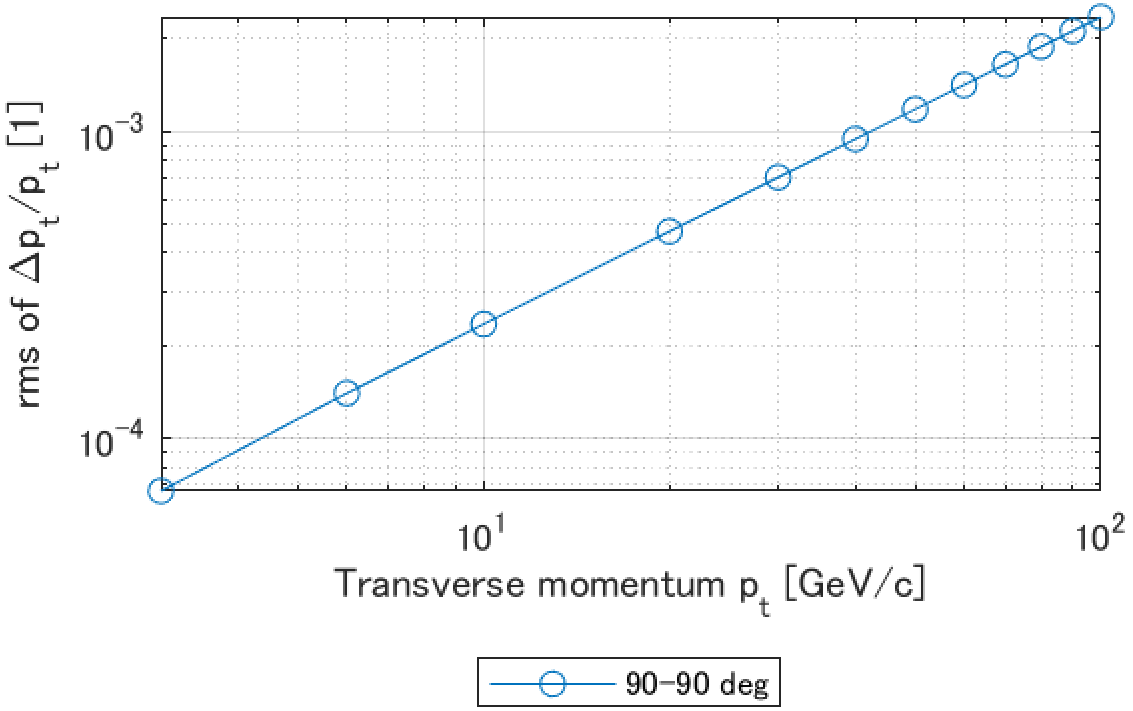
Table 1: default

	p_T(R)	p_T(M)	d_0(R)	d_0(M)	z_0(R)	z_0(M)	$\sigma(\phi)$(R)	$\sigma(\phi)$(M)	$\sigma(\theta)$(R)	$\sigma(\theta)$(M)
p_T	1	0	0	−1	0	−1	0	−1	0	−1
$\sin\theta$	0	−1/2	0	−1/2	0	−3/2	0	−1/2	2	1/2
$\sigma_{r\phi}$	1	0	1	0	0	0	1	0	0	0
σ_z	0	0	0	0	1	0	0	0	1	0
X_i	0	1/2	0	1/2	0	1/2	0	1/2	0	1/2
B	−1	−1	0	0	0	0	0	0	0	0
L	−2	−1	0	0	0	0	−1	0	−1	0
R_0	0	0	0	1	0	1	0	0	0	0
N	−1/2	1/2	−1/2	0	−1/2	0	−1/2	0	−1/2	0

provided from Gang

R=1800mm configuration but without material.

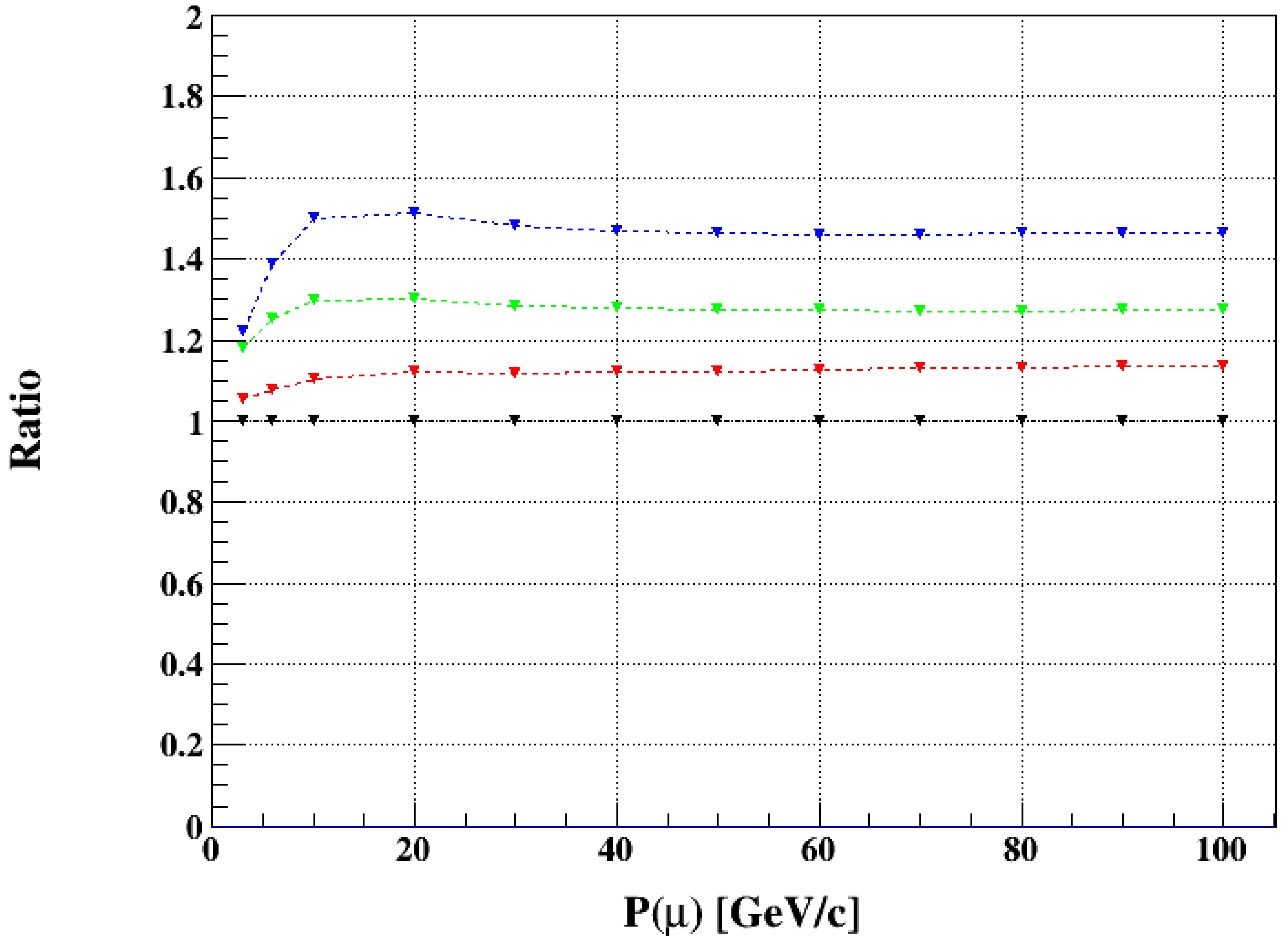
Intrinsic momentum resolution is dominant at higher momentum range.



Mom. res. Ratio to R=1.8m

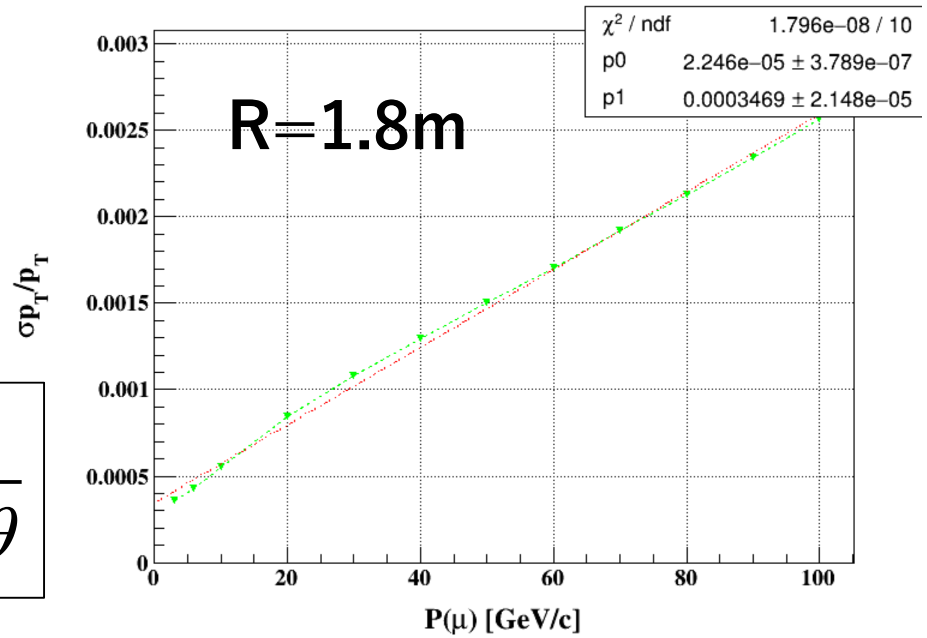
$$\frac{\Delta p_T}{p_T}\Big|_{res.} \approx \frac{12\sigma_{r\phi}\, p_T}{0.3\, BL^2}\sqrt{\frac{5}{N+5}} \quad \propto 1/L^2$$

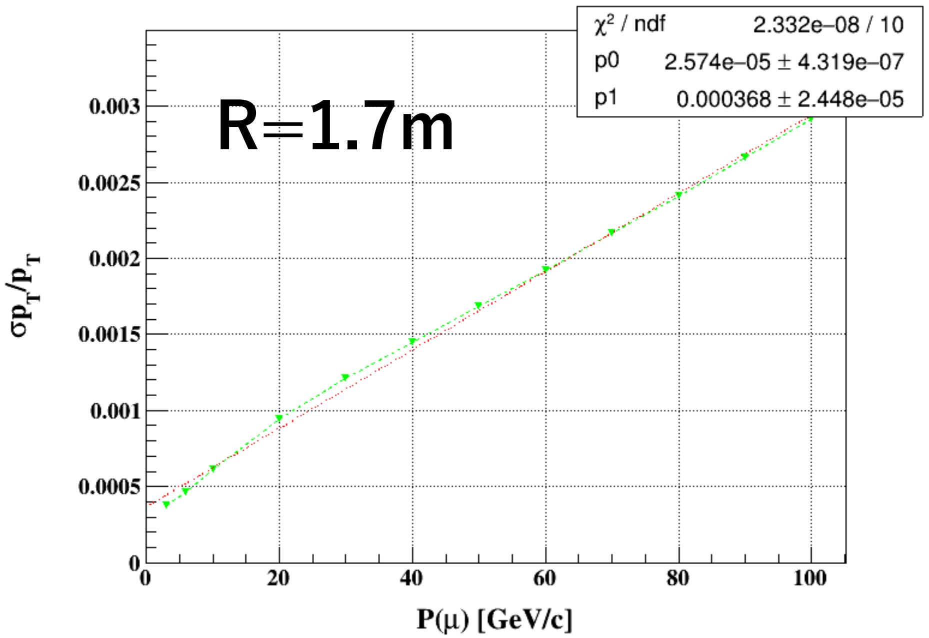
R=1.7m	$(1.8m/1.7m)^2$ = 1.12
R=1.6m	$(1.8m/1.6m)^2$ = 1.27
R=1.5m	$(1.8m/1.5m)^2$ = 1.44



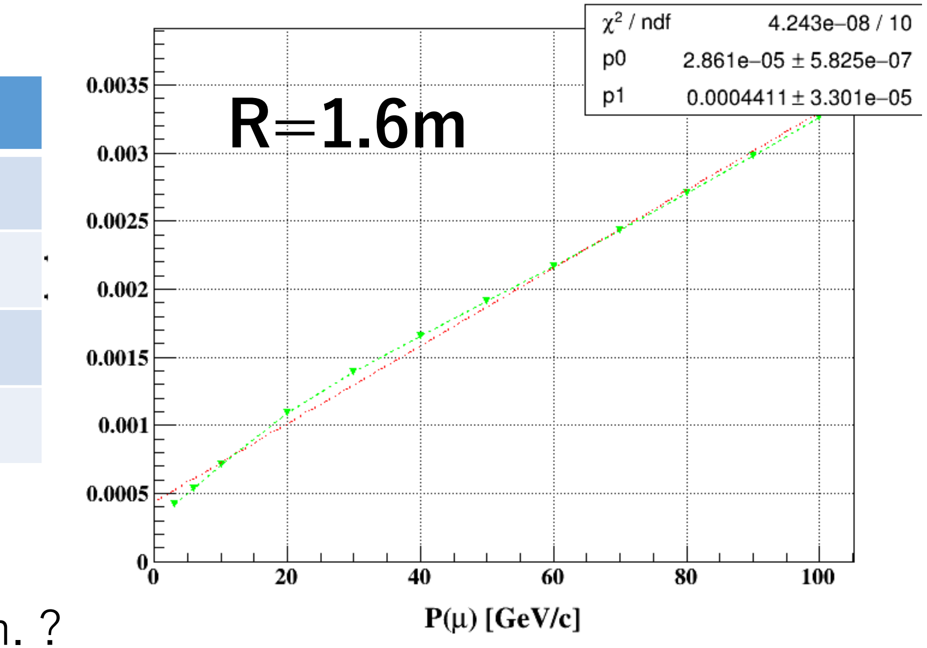
Fitting

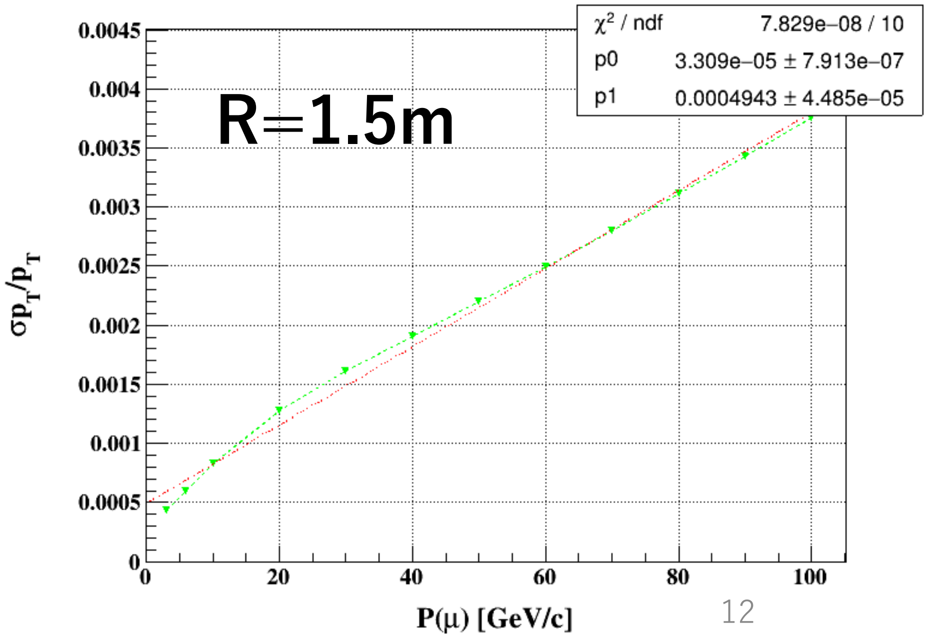
$$\frac{\sigma P_T}{P_T} \sim a \cdot P_T \oplus \frac{b}{\sin^{1/2}\theta}$$





	"a"	"b"
1.8m	2.25E-05	3.47E-04
1.7m	2.57E-05	3.68E-04
1.6m	2.86E-05	4.41E-04
1.5m	3.31E-05	4.94E-04





$a \propto 1/L^2$, $b \propto 1/L$?

remove points of lower mom. ?

σ(1/Pt) ?

・ Except the fitting issues, the results should be the same, but worth to see d(1/pt) = dpt/pt/pt as well ?

・ formula ?

・ at any rate, the “a” term in previous page is the one for d(1/pt) formula.

The track momentum resolution can be parametrized in terms of the resolution on $1/p_T$ as

$$\sigma_{1/p_{\mathrm{T}}} = a \oplus \frac{b}{p \sin^{3/2}\theta} \quad [\mathrm{GeV}^{-1}] \qquad (4.2)$$

where p (p_T) is the (transverse) momentum of the track and θ is the polar angle. The constant term a represents the intrinsic resolution of the tracker and the term with b parametrizes the multiple-scattering effect. The CEPC physics program requires

$$a \sim 2 \times 10^{-5}\,\mathrm{GeV}^{-1} \quad \text{and} \quad b \sim 1 \times 10^{-3}. \qquad (4.3)$$

At $\theta = 90°$, the resolution is dominated by the multiple-scattering effect for tracks with momenta below 50 GeV and by the single-point resolution for tracks with momenta above 50 GeV.

from CEPC CDR

Comments

- Number of hits VS particle injection angle -- under preparation

  -- for the forward tracker part (if $\cos(\theta) > 0.8$ case), would temporally assume the one I have shown in last Month

- Radiation length for different gas-mixture

  (0) 60% He, 40% C3H8 : 0.6/(5.671x10^5) + 0.4/(2.429x10^4) = 0.00001753 (X/X0/cm)

  (1) 50% He, 50% C4H10 : 0.5/(5.671x10^5) + 0.5/(1.817x10^4) = 0.000028399

  (2) 70% He, 30% C4H10 : 0.7/(5.671x10^5) + 0.3/(1.817x10^4) = 0.000017745

  (3) 90% He, 10% C4H10 : 0.9/(5.671x10^5) + 0.1/(1.817x10^4) = 0.0000070905

  … for the moment, pending

Radiation length of each gas is taken from pdg.

$$\frac{\sigma P_T}{P_T} \sim a \cdot P_T \oplus \frac{b}{\sin^{1/2}\theta}$$

$$\Rightarrow \sqrt{\left(a \cdot P_T\right)^2 + \left(\frac{b}{\sin^{1/2}\theta}\right)^2}$$

$$\sigma_{1/P_T} = a \oplus \frac{b}{P_T \sin^{1/2}\theta} = a \oplus \frac{b}{P \sin^{3/2}\theta} \rightarrow \sqrt{a^2 + \frac{1}{P^2} \cdot \frac{b^2}{\sin^3\theta}}$$